Caloosahatchee River Watershed Existing Water Quality Monitoring Inventory					
Organization/Program	**Number of Stations**	**Location**	**Frequency**	**Period**	**Analytes**
Lee County	90 (fixed)	Watershed	Monthly	1990-present	Chlorophyll A ; Pheophytin; Biochemical Oxygen Demand; Cadmium; Chloride; Color; Conductivity; Copper Dissolved Oxygen; Enterococci; Fecal coliform Ammonia; Nitrite; Nitrate; Nitrate + Nitrite; Ortho Phosphorus; Lead; pH; Silica; Total Phosphorus; Water Temperature; Total Kjeldahl Nitrogen; Total Nitrogen; Total Suspended Solids; Turbidity; Velocity of the stream
SFWMD-CR	4 (fixed)	CR-00.2T and CR-04.8T	Bimonthly	1979-present	Alkalinity, Ca, Cl, Color, Conductivity, Dissolved Oxygen, K, Mg, Na, Ammonia, Nitrite, NOX, Orthophosphate, pH, Silica, Sulfate, Temperature, Total Kjeldahl Nitrogen, Total Phosphorus, Total Suspended Solids, Turbidity
		S-78 and S-79		1981-present	
City of Cape Coral	31 (fixed)	Freshwater and Saltwater Canals within City	Monthly	1990-present	Nitrate; Nitrite; Ammonia; Total Kjeldahl Nitrogen; Total Nitrogen; Ortho Phosphate; Organic Phosphorus; Total Phosphorus; Turbidity; Total Dissolved Solids; Total Suspended Solids; Water Temperature; pH; Conductivity; Secchi depth; Fecal streptococcus and Fecal coliforms; Biochemical Oxygen Demand

Caloosahatchee River Estuary Existing Water Quality Monitoring					
Organization/ Program	**Number of Stations**	**Location**	**Frequency**	**Period**	**Analytes**
SFWMD/CESWQ	8 (fixed)	Caloosahatchee River	Monthly	1999-2003	Chlorophyll A ;Chlorophyll A2, Color; Ammonia; Nitrate; Nitrite; Total Kjeldahl Nitrogen; Total Nitrogen; Total Organic Carbon; Ortho Phosphate;Total Phosphorus; Silicate;Total Suspended Solids; Turbidity
	4 (fixed)			1999-present	
SFWMD/CHNEP	5 (random)	Caloosahatchee River	Monthly	2000-present	Chlorophyll A;Color; Nitrite; Nitrate; Nitrate + Nitrite; Total Kjeldahl Nitrogen; Total Nitrogen; Total Organic Carbon; Ortho Phosphate;Total Phosphorus; Silicate;Total Suspended Solids; Turbidity
SFWMD/CESWQ-Release Monitoring	5 (fixed)	Caloosahatchee River	Storm Event/Flow Based Sampling Upon Request	2001-2007	Chlorophyll A ;Chlorophyll A2; Cl; Color; Ammonia; Nitrate + Nitrite; Total Kjeldahl Nitrogen;Total Phosphorus; Total Suspended Solids; Light Attenuation; Salinity; Dissolved Oxygen; pH; Temperature; Secchi Depth
	11 (fixed)			2007-present	
SFWMD/FIU	13 (fixed)	San Carlos Bay, Pine Island Sound and Estero Bay	Monthly	1999-present	Salinity; Temperature; Total Phosphorus; Nitrite; Nitrate; Ammonia; Total Oxidized Nitrogen; Silica; Dissolved Oxygen: Total Organic Carbon; Turbidity; Chlorophyll A2; Ortho Phosphate
SFWMD/CESWQ-Bluegreen algae	8 (fixed)	Caloosahatchee River and Estuary	As required	2005-2006	Chl-a, Microcystin
CHNEP-Coastal Charlotte Harbor Monitoring Network	5 (random) within each waterbody region	Lemon Bay, Charlotte Harbor, Pine Island Sound, Matlacha Pass	Monthly	2001-present	Chlorophyll a; Orthophosphate; Total Phosphorus; Total Kjeldahl Nitrogen; Total Nitrogen; Nitrate-Nitrite; Ammonia; Conductivity; Color; Photosynthecially Active Radiation; pH; Total Organic Carbon; Dissolved Oxygen; Salinity; Turbidity; Secchi Depth; Temperature; Total Suspended Solids
Lee County	14 (fixed)	Pine Island Sound & Matlacha Pass	Monthly	1990-present	Nitrate; Nitrite; Ammonia; Total Kjeldahl Nitrogen; Total Nitrogen; Ortho Phosphorus; Organic Phosphorus; Total Phosphorus; Turbidity; Total Dissolved Solids; Total Suspended Solids; Water Temperature; pH; Conductivity; Secchi depth; Fecal streptococcus and Fecal coliforms; Biochemical Oxygen Demand
City of Cape Coral	2 (fixed)	Caloosahatchee River	Monthly	1990-present	Nitrate; Nitrite; Ammonia; Total Kjeldahl Nitrogen; Total Nitrogen; Ortho Phosphorus; Organic Phosphorus; Total Phosphorus; Turbidity; Total Dissolved Solids; Total Suspended Solids; Water Temperature; pH; Conductivity; Secchi depth; Fecal streptococcus and Fecal coliforms; Biochemical Oxygen Demand
FDEP- South District	12 (fixed)	Caloosahatchee River	Monthly	2008	Chlorophyll a; Dissolved Oxygen; Total Phosphorus; Orthophosphate; pH; Temperature; Total Nitrogen; Nitrate + Nitrite; Total Kjeldahl Nitrogen; Alkalinity; Color; Biological Oxygen Demand; Turbidity; Conductivity
SCCF/RECON	7 in-situ sites	Pine Island Sound; San Carlos Bay; Caloosahatchee River	30-minute intervals	2007-present?	Nitrate; Chlorophyll; Colored Dissolved Organic Matter (CDOM); Conductivity; Dissolved Oxygen; Oxygen Saturation;Turbidity; Salinity; Temperature; Depth
Florida Fish and Wildlife Research Institute/MARVIN	1 site	Caloosahatchee River	3 hour intervals	2005-present	Chlorophyll a, nutrients (nitrogen and phosphorus), water temperature, dissolved oxygen, pH, salinity, turbidity. Also records meteorological data including air temperature, precipitation, barometric pressure, relative humidity, and wind speed and direction.
City of Sanibel	12 (fixed)	Sanibel River and Blind Pass	Monthly	2001-present	Total Suspended Solids: Turbidity; Ammonia; Total Nitrogen; Nitrate + Nitrite; Total Kjeldahl Nitrogen; Nitrate; Nitrite; Orthophosphorus; Total Phosphorus; Chlorophyll A; Conductivity; Salinity; Total Organic Carbon
FDEP-Charlotte Harbor Aquatic Preserve/Volunteer WQ Network	46 (fixed)	Lemon Bay, Charlotte Harbor southward to Estero Bay	Monthly	1998-present	Dissolved Oxygen; Salinity; Chlorophyll A; Turbidity; Color; Total Phosphorus; Total Kjeldahl Nitrogen;Nitrate/nitrite; Fecal coliform; pH; Temperature; Water Depth; Secchi Depth; Tide Stage; Wind speed; Wave height
FDEP-Charlotte Harbor Aquatic Preserve Data Sonde Program	2 (fixed)	Matlacha Pass	15-minute intervals	2005-present	Depth; Water temp; Conductivity; Salinity; pH; Turbidity; Dissolved oxygen
			Monthly	2005-present	Chlorophyll A; Total Kjeldahl Nitrogen;Nitrate/nitrite;Total Phosphorus; Red tide and other HABs; Secchi Depth; Water depth

Hot Issues List for Caloosahatchee River Estuary
02/08/08

FDEP:

P. Fricano

We need to quantify nitrogen loading to Caloosahatchee River and estuary by **nitrogen fixing blue green algae**:

a) between Lake Okeechobee and S-79
b) between S-79 and San Carlos Bay

2. To what degree is "phosphorus driven nitrogen loading" (per question 1) an issue in the Caloosahatchee River and estuary?

3. The nutrient TMDL model for the St. Lucie River and Estuary assumes a TP input of 40 ug/L, coming from Lake Okeechobee. This concentration is consistent with the output TP TMDL for Lake Okeechobee. In light of the fact that the 40 ug/L TP concentration for Lake O will not actually be achieved for several decades, how do we handle the TP concentration as an input to the Caloosahatchee nutrient TMDL model, considering the S-79 boundary condition and downstream waters, which are being modeled first?

4. If "phosphorus driven nitrogen loading" is an issue (per question 2), what TP inputs do we use for the Lower Caloosahatchee TMDL; the existing TP condition at S-79, or the proposed condition of TP at S-79 (per achievement of Lake O's TMDL), per question 3.

N. Bailey

1. Obtain from several locations to get spatial variability (along mainstem and tributaries) of the relationships between BOD5, Ultimate BOD, TOC and DOC Also to do soil particle size distribution from main stem.

J. Nelson

- Drift Algae (multiple species) – Has been a reported problem on beaches, seagrass beds, offshore reefs, and in shrimp nets offshore.
- Blue-green algae blooms in river – predominately *Microcystis* in recent years (could shift to other species e.g. *Anabaena*, *Cylindrospermopsis*, etc.)
- *Trichodesmium* blooms in estuaries (Pine Island Sound, San Carlos Bay)
- *Lyngbya* in estuaries
- Red Tide
- Beach closures (due to bacteria)

- Commercial and recreational fisheries – impacts from Caloosahatchee flows and nutrient loads
- Endocrine Disruptors and Pharmaceuticals/Personal Care Products in surface waters

Current critical questions (incomplete list):

- Nutrient loads to the Caloosahatchee from basin sources (needs to be quantified)
- Suspended sediment dynamics in river and estuary
- Sediment nutrient fluxes in river and estuary
- CDOM characteristics, dynamics and interactions with biotic communities in river, estuary, and offshore

Lee County

T. Pellicer

- Effects of improved freshwater flows on the SAV as well as HABs. (The assumption is to improve flows will provide hospitable habitat for the SAV and they will recover; improved flows will reduce loading swings which promote HABs)
- Effects of freshwater discharges outside the study area (off shore waters). The discharges from the river system are targeted as a contributing factor in algal blooms (red drift and red tide.)
- Assess the freshwater portion of the river's bed load contribution to loading during peak discharges (scouring). Determine whether or not dredging the channel and side channels would reduce the impact of bed load on the estuary and other receiving waters.
- Assess current monitoring programs to identify gaps for both spatial coverage and constituents
- Assess the current flow monitoring efforts in the Caloosahatchee and its tributaries and fill the gaps

City of Cape Coral

C. Jarvis

1. Macroalgae
2. Blue-green blooms – as it gets trapped in our canal systems and stays…..
3. Juvenile fish diversity and density (of course, also can be lake release dependent)
4. Blue crab density – again, probably release dependent
5. Basin inputs vs lake inputs of nutrients

City of Sanibel

J. Evans

Research

- Effects of altered freshwater flow on the ichthyoplankton and decapod community Caloosahatchee. How do high and low flow events affect larval recruitment? What is the impact on local fisheries? (This is not being addressed by our study)
- Submarine groundwater discharge and its contribution to the offshore/nearshore nutrient pool (Hu et al. 2006) (We will get some information on the groundwater nutrient contribution, but additional work may need to be done using radioisotope tracers to get a better understanding of where the nutrients originate)
- Effects of nutrient enriched freshwater inflow on the phytoplankton and macroalgae communities in the Caloosahatchee estuary, San Carlos Bay/ Pine Island Sound and offshore waters of Lee County. (we will be partially addressing this in the FGCU study)
- Benthic nutrient flux work in the river, estuary and San Carlos Bay. What are the benthic nutrient flux rates during the rainy season vs. the dry season? How do high or low flow events affect these benthic nutrient flux rates? (we will be addressing this in our study)
- How do high discharge events affect sediment transport and organic matter deposition? What are the long and short term effects of high flow events? (we will be addressing this in the FGCU study, but may need additional work in the future to look at the long term effects)
- What are the ecological impacts of high accumulation rates of macroalgae on local beaches? (we will be addressing this in the FGCU study)

Monitoring

- Support the use of realtime water quality monitoring efforts in the Caloosahatchee i.e. the SCCF REACON monitoring network
- Continue to support the CHNEP water quality monitoring network
- Support the DEP and USGS flow monitoring efforts in the Caloosahatchee and its tributaries to better understand nutrient loading
- Continue to conduct and support seagrass, oyster and *V. Americana* monitoring in the Caloosahatchee

Chapter 4 Watershed and Estuarine Monitoring Program
4.1 Introduction

The National Oceanographic and Atmospheric Administration has defined ecological monitoring as: The systematic data collection that provides information on changes that can indicate problems and /or progress towards target criteria or performance standards, which, when met, indicated that established ecological goals have been reached (NOAA 2002). More recently they have defined restoration monitoring as: The systematic collection of data that provides information useful for measuring project performance at a variety of scales (locally, regionally and nationally), determining when modification of efforts is necessary, and building log-term public support for habitat protection and restoration (NOAA, 2003).

These definitions identify four components of a monitoring program (1) systematic collection of data that (2) measures change or progress towards (3) a goal, be it a level of project performance or a target and can be used to (4) determine when modifications to the project are required. The issue of spatial scale is also raised.

An important first step in developing a monitoring plan are to identify the goals of the project that is being monitored and identify the type of information that is required to measure progress towards those goals.

Relevant goals of the Caloosahatchee and St. Lucie River Watershed Protection Program as stated in Senate Bill 253 are (1) pollutant load reductions based upon adopted total maximum daily loads (2) salinity envelopes and freshwater inflow targets based on existing research and documentation and (3) reduce the frequency and duration of undesirable salinity ranges while meeting other water –related needs in the region. The legislation also requires an annual report that includes a summary of the conditions of hydrology, water quality and aquatic habitat in the Northern everglades based on the results of the Research and Water Quality Monitoring Programs.

Based on these goals the monitoring program must collect the data necessary to quantify loads to the St. Lucie and Caloosahatchee for pollutants requiring a TMDL. Since loads are calculated from concentration and freshwater discharge, monitoring of these in space and time must be sufficient to support reliable estimation of load. Monitoring of the same pollutant concentrations in estuarine receiving waters must be sufficient to measure progress towards targets or concentrations resulting from nutrient load reductions. The program must also measure those estuarine water quality parameters that are hypothesized to improve through load reduction. For example if a nutrient load reduction was intended to achieve a chlorophyll *a* target in the estuary, then chlorophyll a needs to included in the monitoring program.

Salinity envelopes for the two systems are based on the requirements of biotic resources such as seagrasses and oysters. Monitoring of salinity as required by goal 3 should be

sufficient to measure the frequency and duration of salinities that are undesirable for these biotic resources. Monitoring of the biotic resources is required to determine if reductions in undesirable salinities have the desired ecological result.
Senate Bill 253 requires that monitoring for the Caloosahatchee and St. Lucie River Watershed Protection Program build upon existing monitoring programs. This Chapter summarizes existing monitoring programs. In addition, an assessment of the ability of those monitoring programs to meet the goals of the RWPP in space and time is presented. In conducting that assessment the following questions can serve as a guide.

I. Watershed Nutrient Load:
Is sampling frequent enough? For example, water quality at some water control structures is not even sampled on a monthly basis. Is monitoring of freshwater inflow sufficient? Are there significant ungauged flows that should be monitored?

II. Estuarine Water Quality Monitoring:
Are appropriate water quality parameters being measured? Is monitoring occurring in the right place? For example, if we are reducing loads to the Caloosahatchee Estuary is the number and distribution of stations sufficient to describe the range of water quality encountered? Are we depending on monitoring stations that are too far away from where reductions are occurring to be sensitive to changes in loads?

III. Habitat:

Is sampling frequent enough? Are stations located to be sensitive to changes in flow and loads?

4.2 Watershed Monitoring Program
- **4.2.1 Flow**
- **4.2.2 Water Quality**

4.3 Estuarine Monitoring Program
- **4.3.1 Estuarine Salinity**
- **4.3.2 Estuarine Water Quality**
- **4.3.3 Aquatic Habitat – Oyster and SAV**

RWPP Research and Water Quality Monitoring Plan Outline
02/05/08

1. Introduction
   1.1. Description of Enabling Legislation
   1.2. Document Structure

2. Goals and Objectives of Monitoring and Research

3. The River and Its Watershed: Status, Trends and Targets in Hydrology, Water Quality and Aquatic Habitat
   3.1. Delineation of Study Area
      3.1.1. The River and Estuary
      3.1.2. The Watershed and Lake Okeechobee Connection
   3.2. Watershed Hydrology and Loading
      3.2.1. Hydrology
      3.2.2. Water Quality Status and Trend: Nutrient and DO
      3.2.3. Nutrient Loading
   3.3. River/Estuary Salinity, Water Quality and the Related Aquatic Habitats
      3.3.1. Salinity: Range and Stratification, Flow Correlation
      3.3.2. Water Quality Status and Trend: DO, Nutrients, and Chlorophyll-a, Nutrient Susceptibility Index
      3.3.3. Aquatic Habitats
         3.3.3.1. Submersed Aquatic Vegetation
         3.3.3.2. Oysters
   3.4. Salinity Envelopes and Freshwater Inflow Targets
      3.4.1. Technical Basis
      3.4.2. Envelopes and Targets
   3.5. Influence of Lake Okeechobee and Watershed Discharge on Freshwater Inflow to Estuaries

4. Watershed and Estuarine Monitoring Program
   4.1. Introduction
   4.2. Watershed Monitoring Program
      4.2.1. Flow
      4.2.2. Water Quality (land use, tributaries, structure)
   4.3. Estuarine Monitoring Program
      4.3.1. Estuarine Salinity
      4.3.2. Estuarine Water Quality
      4.3.3. Aquatic habitat – Oysters and SAV
   4.4. Power Analysis
      4.4.1. Water Quality Example
      4.4.2. Submersed Aquatic Vegetation Example

5. Research for Adaptive Management
   5.1. Introduction (Purpose of Research)
   5.2. Status of Current Researches